

APPENDIX C

**INTERIM REPORT ON TASK 3:
FINDINGS AND RECOMMENDATIONS ON THE ECONOMIC
EVALUATION OF ALTERNATIVES**

PACIFIC MISSILE RANGE FACILITY COMBINED HEAT AND POWER FEASIBILITY STUDY

INTERIM REPORT ON TASK 3 Findings and Recommendations on the Economic Evaluation of Alternatives

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**PACIFIC MISSILE RANGE FACILITY
COMBINED HEAT AND POWER FEASIBILITY STUDY**

INTERIM REPORT ON TASK 3

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1 Introduction.....	1
2 Conceptual Designs	2
Alternative No. 1-A: Existing PMRF Power Plant with Heat Recovery and with Intermittent Operation.....	2
Alternative No. 1-B: Existing PMRF Power Plant with Heat Recovery and with Continuous Operation	3
Alternative No. 2-A: New LFGTE Plant at Existing PMRF Power Plant With Microturbine CHP Facility	4
Alternative No. 2-B: New LFGTE Plant at Existing PMRF Power Plant Without Microturbine CHP Facility	7
Alternative No. 3: New LFGTE Plant Near Landfill on PMRF	8
Alternative No. 4: New LFGTE Plant at Landfill	9
3 Construction Costs	15
4 Operation/Maintenance Costs.....	18
5 Energy Savings and Present Worth Analysis.....	22
6 Conclusions.....	27

Tables and Figures

Figure No. 2-1	Site Plan: 1,640 kW Landfill Gas Power Plant at PMRF Power Plant
Figure No. 2-2	Site Plan: Microturbine CHP Plant Near Building 1261
Figure No. 2-3	Site Plan: 1,640 kW Landfill Gas Power Plant on Kokole Point Road
Table No. 3-1	Construction Cost Estimate for the Six Alternatives

**PACIFIC MISSILE RANGE FACILITY
COMBINED HEAT AND POWER FEASIBILITY STUDY**

INTERIM REPORT ON TASK 3

TABLE OF CONTENTS (continued...)

Tables and Figures (continued...)

Table No. 4-1	Annual Operation/Maintenance Costs for the Six Alternatives -- Low Standby Power Cost Scenario
Table No. 4-2	Annual Operation/Maintenance Costs for the Six Alternatives -- Medium Standby Power Cost Scenario
Table No. 4-3	Annual Operation/Maintenance Costs for the Six Alternatives -- High Standby Power Cost Scenario
Table No. 5-1	Annual Energy Savings Associated with the Six Alternatives
Table No. 5-2	Present Worth of the Six Alternatives -- Low Standby Power Cost Scenario
Table No. 5-3	Present Worth of the Six Alternatives -- Medium Standby Power Cost Scenario
Table No. 5-4	Present Worth of the Six Alternatives -- High Standby Power Cost Scenario

SECTION 1

INTRODUCTION

The County of Kauai Office of Economic Development engaged SCS Energy (SCS) to conduct a combined heat and power (CHP) feasibility study for the Pacific Missile Range Facility (PMRF). Task 3 of the work plan for this study calls for:

- Development of site plans for the alternatives selected for further study during Task 2. Six alternatives were selected for further study in Task 2;
- Development of capital and operation/maintenance cost estimates for the alternatives;
- Preparation of a present worth analysis, using the capital and operation/maintenance cost estimates. A twenty year life span is to be employed;
- Preparation of predictions of annual energy and cost savings;
- Recommendation of the optimal system; and
- Submittal of a Task 3 report.

SECTION 2

CONCEPTUAL DESIGNS

The Task 2 report, titled “Energy Baseline Evaluation and CHP Economic and Engineering Options,” recommended that six alternatives be carried forward for more detailed study:

Alternative No. 1-A: Fuel the existing PMRF engines on diesel oil, with the addition of heat recovery, and retain the current program of intermittent engine operation;

Alternative No.1-B: Fuel the existing PMRF engines on diesel oil, with the addition of heat recovery, and convert to full-time operation;

Alternative No. 2-A: New landfill gas fired reciprocating engines located at the existing PMRF power plant, with heat recovery to produce chilled water using absorption chillers, with a microturbine CHP plant near Building 1261;

Alternative No.2-B: New landfill gas fired reciprocating engines located at the existing PMRF power plant, with heat recovery to produce chilled water using absorption chillers, without a microturbine CHP plant near Building 1261;

Alternative No.3: New landfill gas fired reciprocating engines on PMRF grounds close to the landfill; and

Alternative No. 4: New landfill gas fired reciprocating engines located at the landfill.

The subsections which follow describe the six alternatives.

Alternative No. 1-A: Existing PMRF Power Plant with Heat Recovery and with Intermittent Operation

Alternative No. 1-A continues to rely on diesel oil and the existing PMRF engines. Landfill gas would not be employed. The existing PMRF power plant would be converted into a CHP facility.

The two existing 600 kW engines would be retrofitted with hot water recovery equipment. The hot water recovery equipment would consist of water-to-water heat exchangers in the hot water lines to the engine radiators, and gas-to-water heat exchangers in the engine exhaust stacks. The radiators are located outside in the rear of the power plant building. The hot water would be delivered via insulated water piping to a single, new 80-ton absorption chiller located at the power plant. Chilled water would be delivered and returned from Buildings 130, 105 and 105ROCS by insulated, underground chilled water piping. Warm water exiting the absorption chillers would be returned to the diesel engines for reheating.

The existing electric chillers at Buildings 130, 105 and 105ROCS, and the air-cooled condenser unit at 105ROCS would remain as standby units to be pressed into service, if cooling was not available from the new absorption chiller, and to augment the output of the absorption chiller. The capacity of the absorption chiller is constrained by the amount of waste heat available, which is constrained by the fact that the engines usually operate at a maximum of 40 percent of their rated output. The total existing installed chiller capacity at the three buildings is 280 tons. The chilled water from the absorption chillers would be run through new water-to-water heat exchangers installed in the warm water return lines from the buildings. The ability to use chilled water for cooling, in addition to the cooling provided by the air-cooled condenser, would also need to be provided through augmentation of the air handling unit associated with the air-cooled condenser at Building 105ROCS. The electric chiller serving Building 105ROCS appears to be a temporary unit, or at least it is not yet permanently installed. The final details of the cooling arrangement for Building 105ROCS must be developed during detailed design, and the arrangement should be integrated with the future plan for the temporary chiller. A reasonable capital budget will be incorporated into the cost estimate for Alternative No. 1-A to cover uncertainties related to the final chiller configuration.

The energy and economic benefit of adding absorption chilling to the three buildings is a reduction in reliance on electric drive chilling. The reduced electric consumption would ultimately result in reduced diesel oil consumption. The reduction in electric consumption would only occur when the PMRF power plant was operating since hot water would only be produced when the diesel engines were running. The engines currently operate about 2,000 hours per year. The total installed electric drive cooling capacity in these three buildings is 280 tons. The maximum power draw is about 330 kW. Information on the cooling load factor is not available. A daytime load factor of 75 percent will be assumed for the weekday, daytime peak hours (2,000 hours). Based on this assumption, the 80 tons of chilling could always be absorbed, resulting in a reduction in electric power consumption of about 180,000 kWh per year. At an engine heat rate of 11,125 Btu/kWh, the consumption of 14,210 gallons per year of diesel oil would be avoided.

Alternative No. 1-B: Existing PMRF Power Plant with Heat Recovery and with Continuous Operation

PMRF has its greatest power requirement during the normal workday on weekdays. The PMRF power plant is run during this period. PMRF has some power requirement and some cooling requirement on nights and weekends. Alternative No. 1-B is physically the same as Alternative No. 1-A. It differs only in that the engines would continue to run during nights and weekends, at a reduced power output. Continuous operation of the PMRF power plant might be cost-effective, given its new ability to operate in a CHP mode. The purpose of considering this alternative is to evaluate the possibility of continuous operation.

An accurate assessment of whether or not the PMRF power plant should operate during off-peak hours requires knowledge of the power and cooling requirements during off-peak hours, and knowledge of how much of the power requirement is for cooling. The necessary information is not available. Since Alternative No. 1-A and Alternative No. 1-B are physically identical, the decision on whether or not to operate continuously could be made in the future, based on actual operating experience.

For the purposes of this study, it is only necessary to quantify the approximate potential net benefit. If there was a significant potential net benefit, it would enhance the attractiveness of Alternative No. 1-B, in comparison to the other five alternatives. Thus, a roughly quantified benefit at this point in the evaluation is still of use.

Under this alternative, it will be assumed that the diesel engines will operate at their full 1,200 kW, which the total demand of the PMRF main base area requires them to, and that the engines will also operate during the off-peak hours to match the required power demand. The size of the absorption chiller will be increased to 200 tons. The approximate impacts of operation in the above mode are as follows:

- Avoid the equivalent of 900,000 kWh per year in electric consumption for cooling;
- Generate an additional 5,275,000 kW per year on diesel oil;
- Consume an additional 417,000 gallons per year of diesel fuel at PMRF; and
- Reduce KIUC's consumption of diesel oil by 390,000 gallons per year.

A cooling load factor of 75 percent was assumed for the weekday, daytime peak hours. A load factor of 40 percent was assumed for the remaining hours.

Alternative No. 2-A: New LFGTE Plant at Existing PMRF Power Plant With Microturbine CHP Facility

A compressor skid would be located at the landfill. The compressor skid would incorporate the following elements:

- A first stage of pressurization (-50" wc to +5 psig) using centrifugal blowers;
- An interstage gas-to-air heat exchanger;
- A second stage of pressurization (+5 psig to +50 psig) with a sliding vane-type compressor;
- A post-compression gas-to-air heat exchanger;

- A gas-to-gas reheat heat exchanger, a gas-to-chilled water heat exchanger, and a chiller; and
- A final coalescing filter.

The compressor would consume an average of about 100 kW or 815,000 kWh per year.

A 6-inch diameter, below-grade HDPE pipeline would be constructed a distance of about 3.9 miles from the landfill to the existing PMRF power plant. The pipeline would generally parallel Nohili Road.

Two Caterpillar 3516 landfill gas fired reciprocating engines (820 kW x 2 = 1,640 kW) would be located in the vicinity of the existing PMRF power plant. The engines and their switchgear would be installed in a new sheet metal building with the approximate dimensions of 30 feet by 60 feet. Figure No. 2-1 shows a possible location for the building. The final location must be selected in cooperation with PMRF. The heat recovery element of Alternative No. 2-A would be essentially the same as that described for Alternative No. 1-A. The capacity of the chiller would be increased to 280 tons.

A microturbine CHP facility will be installed to provide cooling to Buildings 1260, 1261, 1262 and 1264, and hot water to Buildings 1261 and 1262. The microturbine CHP facility would consist of:

- Four 60 kW microturbines, a hot gas driven, double-effect absorption chiller, and a waste heat hot water generator;
- A landfill gas pressurization and treatment skid consisting of a sliding vane-type compressor (45 psig to 80 psig), and a fixed media (silica gel) non-regenerable siloxane treatment system;
- Below-ground, insulated, chilled water delivery and return water piping from the microturbine CHP facility to Buildings 1260, 1261, 1262 and 1264 and below ground, insulated hot water delivery and return water piping from the microturbine CHP facility to Buildings 1261 and 1262; and
- Connections and valving from the above chilled water and return water piping to the existing chilled water and return water piping associated with the chillers at Buildings 1260, 1261 and 1262. Modifications to the building cooling system at Building 1264 will be made to allow cooling to be supplied by the air-cooled condenser or the chilled water from the microturbine CHP facility.

The installed cooling capacity at Buildings 1260, 1261, 1262 and 1264 is about 60 tons. The full output capability of the microturbine CHP facility would be 120 tons of cooling or 1.1 mmBtu/hr of hot water. The capacity of the hot water generator at Building 1262, serving Buildings 1262

and 1261, is 0.34 mmBtu/hr. The microturbine CHP facility will be able to cover the peak cooling and hot water loads at all of the buildings.

At full output, in warm weather, the microturbine CHP facility will provide an average net power output of 180 kW. The power required by the booster compressor, the absorption chiller and the water pumps has been considered in arriving at the net power output. The microturbine CHP facility will require approximately 90 scfm of landfill gas.

The use of the landfill gas at the microturbine CHP facility represents landfill gas not available for use at the reciprocating engine power plant.

If it is assumed that the installed absorption chiller cooling capacity has a utilization factor of 40 percent on an annual basis, the substitution of absorption chilling for electric drive cooling will save the equivalent of about 250,000 kWh per year.

If it is assumed that the existing hot water generator has a utilization factor of 15 percent, then consumption of about 496 mmBtu per year of propane (or about 5,230 gallons) will be avoided.

The power requirement at the PMRF main base point of service averages 750 kW and peaks at about 1,400 kW. If a 1,640 kW (gross), 1,525 kW (net) landfill gas fired reciprocating engine power plant is located at the existing PMRF power plant, then about 5,346,000 kWh of “excess” power is available for export to KIUC through the PMRF main base point of service. Based on a preliminary appraisal of the on-site power distribution system, this could be accomplished without upgrading the distribution system. The approach would be as follows:

- The two new generators would produce power at 4,160 V and connect into the low voltage side of the 4,160 V/12.47 kV “KE feeder” transformer at the power plant; and
- The south loop breaker would be closed.

As an alternative to selling all of the excess power to KIUC, the Navy Housing point of service could be connected to the PMRF main base point of service. The Navy Housing point of service has an average demand of 350 kW and a peak demand of 700 kW. In order to service this load, it will be necessary to:

- Install about 5,500 feet of below-ground 12.47 kV cable due south of the PMRF power plant along Nohili Road;
- Install about 8,300 feet of above-ground 12.47 kV cable beyond the underground cable to the Navy Housing area. About 6,600 feet of this cable could be strung on existing poles; and
- Disconnect the KIUC Navy Housing point of service.

The above modifications will cost in the vicinity of \$1,230,000. The benefit to PMRF is that the power transferred to the Navy Housing point of service would be worth a net of \$0.264/kWh versus the \$0.175/kWh KIUC pays for excess power produced by cogenerators. The marginal benefit to PMRF would be about \$163,000 per year. The calculated benefit has been reduced by the consideration that about 180 kW of the average load of 350 kW is being satisfied by the microturbine CHP facility. The simple payback is about 7.5 years. It will be assumed that the interconnecting distribution line between the PMRF power plant and the Navy Housing area will be built.

The microturbine CHP facility will produce power at 480 V. It will be stepped up to 12.47 kV and connected into the nearest 12.47 kV power line.

The microturbine CHP facility has been tentatively located behind Building 1261. Figure No. 2-2 presents a tentative general arrangement plan for the microturbine CHP facility.

Alternative No. 2-A will accomplish the following:

- Produce an average of 12,210,100 kWh per year of renewable power over its 20-year life;
- Eliminate about 112,000 gallons per year of diesel oil consumption by the PMRF power plant; and
- Produce the equivalent of 714,000 gallons per year of diesel oil savings at KIUC's power plant through elimination of power purchases and through delivery of "excess" power to KIUC.

While the above outlines a technical approach to serving the Navy Housing area, a contractual issue also exists. Significant segments of the power distribution system within the Navy Housing area are not owned by PMRF. If the Navy Housing point of service is disconnected from KIUC, then these segments must be bought from KIUC. Whether KIUC would be willing to sell them at a reasonable price is not known. If this contractual issue could not be worked out, the tie line between the PMRF main base and the Navy Housing area would not be installed. If the interconnection was not installed, approximately 1,834,000 kWh per year would be shifted from the category of avoided KIUC power purchases to the category of delivery of excess power to KIUC. The \$1,230,000 capital investment would be avoided, and PMRF would lose \$163,000 per year in net revenue. It should also be noted that payment of any amount to KIUC, to resolve this contractual issue, would increase the projected payback period beyond 7.5 years.

Alternative No. 2-B: New LFGTE Plant at Existing PMRF Power Plant Without Microturbine CHP Facility

From a physical facilities perspective, Alternative No. 2-B is Alternative No. 2-A without the microturbine CHP facility. The following non-physical impacts will occur:

- On-site electric power production will increase from an average of 12,210,000 kWh per year to 12,691,900 kWh per year, since the reciprocating engines are more efficient than microturbines;
- The 250,000 kWh of electric power consumption that would have been deferred by the microturbine CHP facility's satisfaction of the cooling loads of four buildings in the Navy Housing area would be lost. The net impact, on equivalent power production, would, however, still be a gain of 231,800 kWh per year. The above conclusion is counterintuitive. Elimination of the microturbine CHP facility actually enhances energy efficiency. The microturbine CHP facility proposed herein is the smallest commercially available unit. Only about 23 percent of the theoretically available tons of cooling are being productively used due to the lack of cooling load. The amount of cooling productively used cannot offset the inefficiency of the microturbine versus a reciprocating engine. A microturbine's heat rate is 14,300 Btu/kWh versus 10,900 Btu/kWh for a reciprocating engine;
- If an interconnection between PMRF main base and Navy Housing was not made, then more of the total power produced would be sold to KIUC versus the power being used at PMRF. This is because none of the Navy Housing point of connection would be served by PMRF self-generated power. In order to serve the Navy Housing point of service, the distribution system modifications discussed under Alternative No. 2-A would need to be made. The payback on this investment would reduce from 7.5 years to 4.3 years. It will be assumed that the distribution system modifications will be made. The above-discussed KIUC contractual issue must, of course, still be addressed; and
- Propane consumption would not be reduced by 5,230 gallons per year.

Alternative No. 2-B will accomplish the following:

- Produce an average of 12,691,900 kWh per year of renewable power over its 20-year life;
- Eliminate about 112,000 gallons per year of diesel oil consumption by the PMRF power plant; and
- Produce the equivalent of 729,000 gallons of diesel oil savings at KIUC's power plant through elimination of power purchases and the delivery of "excess" power to KIUC.

Alternative No. 3: New LFGTE Plant Near Landfill on PMRF

Under Alternative No. 3, a 1,640 kW landfill gas fired reciprocating engine power plant would be located along Kokole Point Road. A tentative location is shown on Figure No. 2-3. The power plant would not be equipped for heat recovery.

Because the power plant is located close to the landfill, it will be possible to eliminate the compressor skid at the landfill. A 12-inch diameter, 1,000-foot long, underground HDPE landfill gas delivery pipe would be extended from the landfill to the power plant location. The pipe would operate under a slight vacuum. Two or three low point sumps would be located along this pipe to collect condensate. The sumps would be equipped with pneumatic sump pumps. A 2-inch condensate return line, and a 2-inch compressed air line would be co-located with the landfill gas pipe in the landfill gas pipe trench. The condensate and air lines would originate at the landfill.

Landfill gas would be pressurized at the power plant with centrifugal blowers. The landfill gas would be cooled in an air-to-gas heat exchanger, and would then pass through a moisture separator and a coalescing filter, before entering the landfill gas pipeline.

In order to serve all three of PMRF's main KIUC points of service for the new power plant, it will be necessary to run a new 12.47 kV distribution line down Kokole Point Road to Nohili Road, and then along Nohili Road through the Navy Housing area, and then up to the existing PMRF power plant. The distribution line would cover a distance of 14,850 feet on new poles, 6,600 feet on existing poles, and 5,500 feet underground.

Power at the new power plant would be generated at 4,160 V. It would be stepped up to 12.47 kV at the new power plant. The KIUC service point at Navy Housing would be eliminated. The KIUC service point at PMRF main base would also be eliminated.

Alternative No. 3 would accomplish the following:

- Produce an average of about 12,057,300 kWh per year of power over its 20-year life;
- Eliminate about 112,000 gallons per year of diesel oil consumption by the PMRF power plant; and
- Produce the equivalent of 672,000 gallons of diesel oil savings at KIUC's power plant through elimination of power purchases and delivery of "excess" energy to KIUC.

Alternative No. 4: New LFGTE Plant at Landfill

Under Alternative No. 4, a 1,640 kW landfill gas fired reciprocating engine power plant would be installed at the landfill. It would not be equipped with heat recovery. The 1,000-foot long 12-inch diameter connecting pipe, required under Alternative No. 3, would be eliminated. The inlet vacuum of the centrifugal blowers would be lowered by one psig.

The power plant would interconnect directly to KIUC. The power plant would produce 12,057,300 kWh of renewable power per year, avoiding about 761,600 gallons per year of oil consumption at KIUC's central power plant.

The power plant at the landfill could be:

- 1) Owned by PMRF with the output sold to KIUC. The revenue generated at the landfill through sale of power to KIUC could offset the cost of power PMRF purchases from KIUC;
- 2) Owned by KIUC (with KIUC buying landfill gas from the County);
- 3) Owned by the County with sale of power to KIUC; or
- 4) Owned by a private developer, buying landfill gas from the County, and the private developer selling power to KIUC.

Because this study is addressing PMRF's needs, ownership by PMRF will be presumed; however, one of the other ownership configurations may result in more net revenue to the County.

Under the PMRF ownership configuration, it will be assumed that PMRF would receive 17.5¢/kWh for power sold to KIUC. KIUC makes an energy credit payment to cogenerators under KIUC's Schedule Q. The Schedule Q rate varies monthly and is benchmarked to the price of oil. The Schedule Q rate averaged 17.5¢/kWh in 2006. The project configuration technically does not satisfy the specific requirements of Schedule Q in that the power plant is not a cogeneration plant, and the credit would be applied to billings on meters not connected to the power plant. The power plant could nominally be converted into a cogeneration facility by finding a productive use for heat at the landfill (e.g., condensate or leachate evaporation).

A possibly more favorable scenario to PMRF would be for KIUC to accept the power generated by PMRF and to transmit ("wheel") it to PMRF's existing points of connection to PMRF. Under such an arrangement, KIUC would charge a fixed monthly \$/kW charge or a ¢/kWh charge for transmission service. KIUC does not have a policy on wheeling and for this reason, it will be assumed that all power produced by PMRF will have a value of 17.5¢/kWh.

It should be noted that 17.5¢/kWh (wholesale) is substantially lower than the 29.4¢/kWh (average retail price) that PMRF paid KIUC for power in 2005/2006. It is also less than PMRF would net from on-site generation. The net value for on-site generated power would be about 28.0¢/kWh (29.4¢/kWh less KIUC charges for standby power). KIUC currently charges \$5.00 per month per kW of standby demand, as is specified in KIUC's published Rider "S." KIUC's standby charge is roughly equivalent to 1.4¢/kWh.

On October 31, 2006, KIUC's Board of Directors adopted a resolution that would increase KIUC's standby charge for Schedule "P" customers to \$37.47/kW. The proposed increase is subject to review and approval by the Hawaii Public Utilities Commission (PUC). The PUC can accept, modify or defer implementation of the proposed standby rate, until a certain percentage of load has been lost by KIUC to parties generating their own power. Under a worst case

scenario, the standby charge could increase to the equivalent of 10.5¢/kWh in the future. KIUC's current Schedule P demand charge is \$10.45/kW. Generally, a utility's standby charge is lower than its demand charge. A standby charge based on \$10.45/kWh would be roughly equivalent to 3.0¢/kWh.

If it is assumed that PMRF will continue to operate its power plant as it is currently operated, the impact of Alternative No. 4 would be the delivery of an average of 12,057,300 kWh per year to KIUC, reducing KIUC's oil consumption by 761,600 gallons per year.

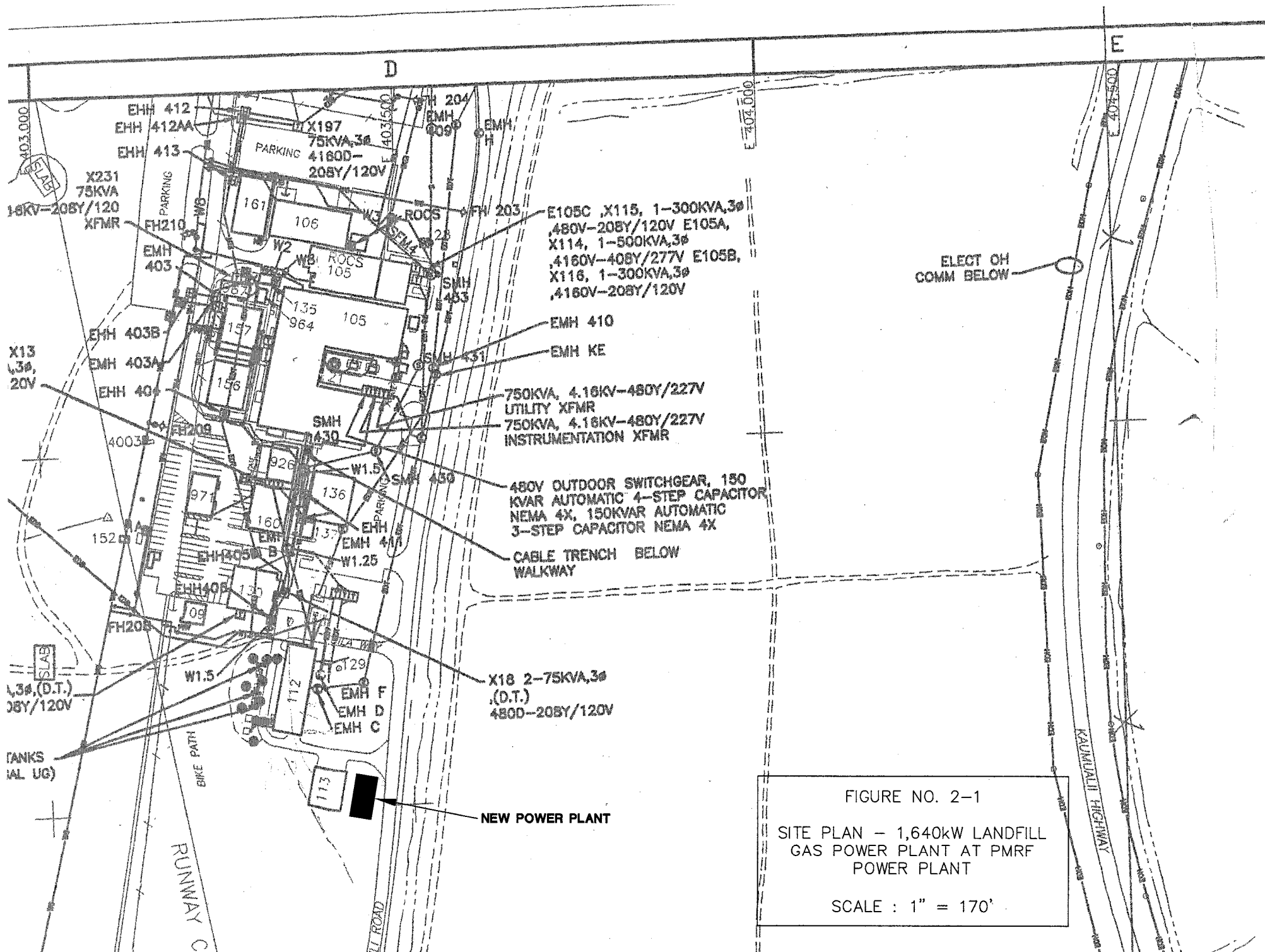
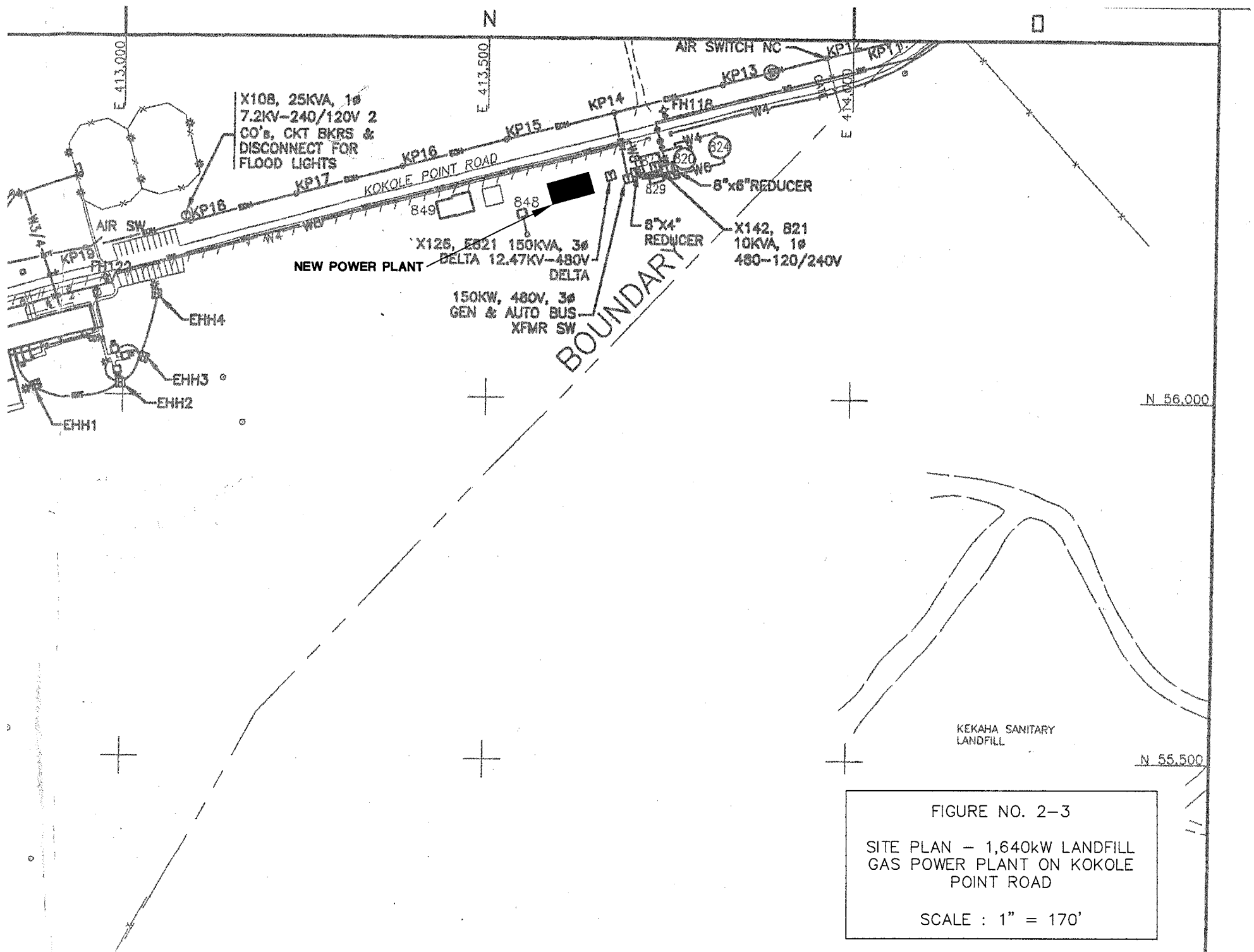


FIGURE NO. 2-1

SITE PLAN - 1,640kW LANDFILL
GAS POWER PLANT AT PMRF
POWER PLANT

SCALE : 1" = 170'



SECTION 3

CONSTRUCTION COSTS

Table No. 3-1 provides a construction cost estimate for each of the six alternatives. The paragraphs which follow provide an explanation of important line items found on Table No. 3-1.

The cost for the reciprocating engines includes the cost of two Caterpillar 3516 engine/generators and appurtenant equipment (radiators, silencers, etc.). The equipment cost, as with all other equipment costs cited on Table No. 3-1, also include contractor's markup, shipping cost and installation cost.

The cost for microturbines, applicable only to Alternative No. 2-A, includes four 60 kW microturbines, equipped with an absorption chiller and hot water recovery, as available from UTC.

The chillers, applicable to Alternative Nos. 1-A, 1-B, 2-A and 2-B, are single-effect, hot water absorption chillers.

The heat exchangers for Alternative Nos. 1-A and 1-B include water-to-water waste heat recovery exchangers installed in the cooling water loop of both of the existing 600 kW engines, an exhaust-to-hot water heat exchanger in both of the engines' exhaust stacks, and an air-to-hot water waste heat heat exchanger to match hot water production with absorption chiller heat demand.

The heat exchangers for Alternative Nos. 2-A and 2-B include the same heat exchange configuration described above; however, they are applied to two 820 kW engines.

The absorption chiller under Alternative No. 2-A does not require a hot water heat exchanger since it operates on hot exhaust gas. A small hot water heat exchanger will be employed to supply the hot water demands of two of the buildings served.

Pumps include hot pumps for the hot water recirculating pumps, for all alternatives, and chilled water pumps for Alternative No. 2-A's chilled water loop.

The landfill gas skid under Alternative No. 2-A and 2-B is identical and is a high-pressure skid equipped with chilling and reheat of the landfill gas. Alternative No. 2-A requires a booster compressor at the microturbine CHP facility. Alternative Nos. 3 and 4 do not require compression. They rely on a centrifugal blower with an air-to-gas aftercooler.

The largest component of the line item titled “Landfill Gas Piping” under Alternative Nos. 2-A and 2-B is the 3.9-mile landfill gas transmission pipeline from the landfill to the PMRF power plant.

The “PMRF Grid Improvements” line item pertains only to Alternative Nos. 2-A, 2-B and 3. Under Alternative No. 3, it is necessary to link Kokole Point to Navy Housing through to the PMRF main base to make maximum on-site use of the power which is being generated by Alternative No. 3’s power plant. Under Alternative Nos. 2-A and 2-B, PMRF main base is linked with Navy Housing to provide the Navy Housing area with power.

**TABLE NO. 3-1
CONSTRUCTION COST ESTIMATES FOR THE SIX ALTERNATIVES**

	Alt No. 1-A Existing PMRF with Heat Recovery with Intermittent Ops	Alt No. 1-B Existing PMRF with Heat Recovery with Continuous Ops	Alt No. 2-A New LFGTE at Existing PMRF With Microturbines	Alt No. 2-B New LFGTE at Existing PMRF Without Microturbines	Alt No. 3 New LFGTE Near Landfill on PMRF	Alt No. 4 New LFGTE at Landfill
<i>Major Mechanical Equipment</i>						
Reciprocating Engines	\$0	\$0	\$1,350,000	\$1,350,000	\$1,350,000	\$1,350,000
Microturbines	\$0	\$0	\$460,000	\$0	\$0	\$0
Chillers	\$148,000	\$296,000	\$355,000	\$355,000	\$0	\$0
Heat Exchangers	\$72,000	\$108,000	\$165,000	\$115,000	\$0	\$0
Pumps	\$16,000	\$20,000	\$33,000	\$22,000	\$0	\$0
Landfill Gas Skid	\$0	\$0	\$460,000	\$420,000	\$205,000	\$195,000
<i>Piping and Related</i>						
Landfill Gas Piping	\$0	\$0	\$604,000	\$604,000	\$83,200	\$0
Hot Water Piping	\$26,000	\$39,000	\$68,900	\$42,900	\$13,000	\$13,000
Warm Water Piping	\$13,000	\$19,500	\$48,100	\$22,100	\$13,000	\$13,000
Chilled Water Piping	\$71,500	\$97,500	\$201,500	\$104,000	\$0	\$
Other Piping	\$0	\$0	\$175,500	\$162,500	\$162,500	\$162,500
Chilled Water Conversions	\$13,000	\$13,000	\$26,000	\$13,000	\$0	\$0
<i>Civil</i>						
Grading/Site Work	\$0	\$0	\$117,000	\$104,000	\$52,000	\$65,000
Foundations	\$6,500	\$13,000	\$201,500	\$182,000	\$143,000	\$143,000
Buildings	\$0	\$0	\$175,500	\$175,500	\$175,500	\$175,500
<i>Electrical</i>						
Transformers	\$0	\$0	\$71,500	\$52,000	\$117,000	\$117,000
Switchgear	\$0	\$0	\$396,500	\$357,500	\$260,000	\$260,000
Utility Interconnect	\$0	\$0	\$0	\$0	\$0	\$200,000
PMRF Grid Improvements	\$0	\$0	\$1,230,000	\$1,230,000	\$2,130,000	\$0
Power Conduit/Cable	\$10,400	\$15,600	\$383,500	\$331,500	\$305,500	\$292,500
Control Conduit/Cable	\$2,600	\$2,600	\$188,500	\$162,500	\$162,500	\$162,500
Control System	\$10,400	\$10,400	\$182,000	\$143,000	\$104,000	\$104,000
<i>Landfill Gas Collection System</i>						
Landfill Gas Collection System	\$0	\$0	\$379,000	\$379,000	\$379,000	\$379,000
<i>Engineering/Technical</i>						
Permits	\$0	\$0	\$45,000	\$45,000	\$45,000	\$45,000
Detailed Design	\$40,000	\$40,000	\$415,000	\$370,000	\$380,000	\$320,000
Construction Observation	\$15,000	\$15,000	\$166,000	\$166,000	\$166,000	\$166,000
Total	\$444,400	\$689,600	\$7,898,000	\$6,908,500	\$6,246,200	\$4,163,000
Contingency (10%)	\$44,440	\$68,960	\$789,800	\$690,850	\$624,620	\$416,300
GRAND TOTAL	\$488,840	\$758,560	\$8,687,800	\$7,599,350	\$6,870,820	\$4,579,300

SECTION 4

OPERATION/MAINTENANCE COSTS

Table Nos. 4-1, 4-2 and 4-3 summarize the operation/maintenance cost of the six alternatives. As discussed in Section 2, KIUC intends to increase its standby power charge. The standby power charge directly affects the net revenue produced by deferred power purchases. Table No. 4-1 employs the current (lowest) standby charge. Table No. 4-2 employs a standby charge roughly double the current standby charge, and equal to KIUC's demand charge for Schedule "P." Table No. 4-3 employs the proposed (highest) standby charge.

The line item titled "Fuel Cost" includes the impact of the incremental increase or decrease in PMRF diesel oil purchases, where such changes occur, at a diesel oil price of \$2.44 per gallon. PMRF's cost of diesel fuel averaged \$2.44 per gallon in 2005/2006. Landfill gas consumed by any alternative is costed at \$1.00/mmBtu. The actual price for the landfill gas would be subject to negotiation between PMRF and the County. Increases or decreases to the price would directly affect the bottom line of the landfill gas fired alternatives.

Included in the line item titled "Electric Power" is the cost of power that might otherwise not be purchased from KIUC. Under Alternative Nos. 2-A and 2-B, the gas compression skid at the landfill would require power from KIUC. Alternative Nos. 3 and 4 avoid most of this cost since their landfill gas blowers would use self-generated power almost all of the time. The use of this self-generated power is considered in the net power output assigned to these two alternatives. If Alternative No. 2-A or 2-B is implemented, installation of a microturbine at the skid might be considered as an optimization step.

In the revenue section of Table No. 4-1, the following assumptions were made:

- The cost of propane is \$2.50 per gallon;
- Deferred KIUC power purchases are valued at 28.0¢/kWh, 26.4¢/kWh and 18.9¢/kWh (current retail rate of 29.4¢/kWh less standby power charges of 1.4¢/kWh, 3.0¢/kWh and 10.5¢/kWh); and
- Power sold to KIUC is valued at 17.5¢/kWh (KIUC's cogenerator energy credit under Schedule Q for 2006).

TABLE NO. 4-1
ANNUAL OPERATION/MAINTENANCE COSTS FOR THE SIX ALTERNATIVES
LOW STANDBY POWER COST SCENARIO

	Alt No. 1-A Existing PMRF with Heat Recovery with Intermittent Ops	Alt No. 1-B Existing PMRF with Heat Recovery with Continuous Ops	Alt No. 2-A New LFGTE at Existing PMRF With Microturbines	Alt No. 2-B New LFGTE at Existing PMRF Without Microturbines	Alt No. 3 New LFGTE Near Landfill on PMRF	Alt No. 4 New LFGTE at Landfill
Fuel Cost (Diesel/Landfill Gas)	-\$34,670	+\$1,017,480	+\$141,300	+\$141,300	+\$141,300	+\$141,300
Electric Power	No change	No change	+\$240,000	+\$240,000	No change	No change
Other Consumables	+\$7,000	+\$10,000	+\$15,000	+\$11,000	+\$2,000	+\$2,000
Equipment Maintenance	+\$7,000	+\$50,000	+\$190,000	+\$150,000	+\$140,000	+\$140,000
Labor	No change	+\$245,000	+\$163,000	+\$123,000	+\$123,000	+\$245,000
Miscellaneous Costs	No change	+\$5,000	+\$10,000	+\$10,000	+\$10,000	+\$10,000
Total Annual Cost	-\$20,670	+\$1,327,480	+\$759,300	+\$675,300	+\$416,300	+\$538,300
Deferred Propane Purchases	No change	No change	-\$13,070	No change	No change	No change
Deferred Diesel Purchases	No change	No change	-\$273,300	-\$273,000	-\$273,000	No change
Deferred Power Purchases	No change	-\$1,820,000	-\$2,526,400	-\$2,526,400	-\$2,643,000	No change
Power Sold to KIUC	No change	No change	+\$558,000	+\$642,000	+\$458,000	+\$2,110,000
Total Revenue from Power	No change	+\$1,820,000	+\$3,084,400	+\$3,168,400	+\$3,101,000	+\$2,110,000
Total Annual Revenue	No change	+\$1,820,000	+\$3,370,770	+\$3,441,400	+\$3,374,000	+\$2,110,000
Net Annual Savings	+\$20,670	+\$492,520	+\$2,611,470	+\$2,766,100	+\$2,957,700	+\$1,571,700

TABLE NO. 4-2
ANNUAL OPERATION/MAINTENANCE COSTS FOR THE SIX ALTERNATIVES
MEDIUM STANDBY POWER COST SCENARIO

	Alt No. 1-A Existing PMRF with Heat Recovery with Intermittent Ops	Alt No. 1-B Existing PMRF with Heat Recovery with Continuous Ops	Alt No. 2-A New LFGTE at Existing PMRF With Microturbines	Alt No. 2-B New LFGTE at Existing PMRF Without Microturbines	Alt No. 3 New LFGTE Near Landfill on PMRF	Alt No. 4 New LFGTE at Landfill
Fuel Cost (Diesel/Landfill Gas)	–\$34,670	+\$1,017,480	+\$141,300	+\$141,300	+\$141,300	+\$141,300
Electric Power	No change	No change	+\$240,000	+\$240,000	No change	No change
Other Consumables	+\$7,000	+\$10,000	+\$15,000	+\$11,000	+\$2,000	+\$2,000
Equipment Maintenance	+\$7,000	+\$50,000	+\$190,000	+\$150,000	+\$140,000	+\$140,000
Labor	No change	+\$245,000	+\$163,000	+\$123,000	+\$123,000	+\$245,000
Miscellaneous Costs	No change	+\$5,000	+\$10,000	+\$10,000	+\$10,000	+\$10,000
Total Annual Cost	–\$20,670	+\$1,327,480	+\$759,300	+\$675,300	+\$416,300	+\$538,300
Deferred Propane Purchases	No change	No change	–\$13,070	No change	No change	No change
Deferred Diesel Purchases	No change	No change	–\$273,300	–\$273,000	–\$273,000	No change
Deferred Power Purchases	No change	–\$1,716,000	–\$2,382,000	–\$2,382,000	–\$2,492,000	No change
Power Sold to KIUC	No change	No change	+\$558,000	+\$642,000	+\$458,000	+\$2,110,000
Total Revenue from Power	No change	+\$1,716,000	+\$2,940,000	+\$3,024,000	+\$2,950,000	+\$2,110,000
Total Annual Revenue	No change	+\$1,716,000	+\$3,226,370	+\$3,297,000	+\$3,223,000	+\$2,110,000
Net Annual Savings	+\$20,670	+\$388,520	+\$2,467,070	+\$2,621,700	+\$2,806,700	+\$1,571,700

TABLE NO. 4-3
ANNUAL OPERATION/MAINTENANCE COSTS FOR THE SIX ALTERNATIVES
HIGH STANDBY POWER COST SCENARIO

	Alt No. 1-A Existing PMRF with Heat Recovery with Intermittent Ops	Alt No. 1-B Existing PMRF with Heat Recovery with Continuous Ops	Alt No. 2-A New LFGTE at Existing PMRF With Microturbines	Alt No. 2-B New LFGTE at Existing PMRF Without Microturbines	Alt No. 3 New LFGTE Near Landfill on PMRF	Alt No. 4 New LFGTE at Landfill
Fuel Cost (Diesel/Landfill Gas)	-\$34,670	+\$1,017,480	+\$141,300	+\$141,300	+\$141,300	+\$141,300
Electric Power	No change	No change	+\$240,000	+\$240,000	No change	No change
Other Consumables	+\$7,000	+\$10,000	+\$15,000	+\$11,000	+\$2,000	+\$2,000
Equipment Maintenance	+\$7,000	+\$50,000	+\$190,000	+\$150,000	+\$140,000	+\$140,000
Labor	No change	+\$245,000	+\$163,000	+\$123,000	+\$123,000	+\$245,000
Miscellaneous Costs	No change	+\$5,000	+\$10,000	+\$10,000	+\$10,000	+\$10,000
Total Annual Cost	-\$20,670	+\$1,327,480	+\$759,300	+\$675,300	+\$416,300	+\$538,300
Deferred Propane Purchases	No change	No change	-\$13,070	No change	No change	No change
Deferred Diesel Purchases	No change	No change	-\$273,300	-\$273,000	-\$273,000	No change
Deferred Power Purchases	No change	-\$1,229,000	-\$1,705,000	-\$1,705,000	-\$1,784,000	No change
Power Sold to KIUC	No change	No change	+\$558,000	+\$642,000	+\$458,000	+\$2,110,000
Total Revenue from Power	No change	+\$1,229,000	+\$2,263,000	+\$2,347,000	+\$2,242,000	+\$2,110,000
Total Annual Revenue	No change	+\$1,229,000	+\$2,549,370	+\$2,620,000	+\$2,515,000	+\$2,110,000
Net Annual Savings	+\$20,670	-\$98,480	+\$1,790,070	+\$1,944,700	+\$2,098,700	+\$1,571,700

SECTION 5

ENERGY SAVINGS AND PRESENT WORTH ANALYSIS

Table No. 5-1 summarizes the energy savings associated with each alternative from two points of view -- PMRF view and island-wide view.

The present worths of the six alternatives, under the three standby power cost scenarios, using a 20-year life and an eight percent discount factor, are summarized on Table Nos. 5-2, 5-3 and 5-4.

TABLE NO. 5-1
ANNUAL ENERGY SAVINGS ASSOCIATED WITH THE SIX ALTERNATIVES

	Alt No. 1-A Existing PMRF with Heat Recovery with Intermittent Ops	Alt No. 1-B Existing PMRF with Heat Recovery with Continuous Ops	Alt No. 2-A New LFGTE at Existing PMRF With Microturbines	Alt No. 2-B New LFGTE at Existing PMRF Without Microturbines	Alt No. 3 New LFGTE Near Landfill on PMRF	Alt No. 4 New LFGTE at Landfill
<i>PMRF Perspective</i>						
Propane Consumption (Gal)	No change	No change	-5,230	No change	No change	No change
Diesel Oil Consumption (Gal)	-14,210	+417,000	-112,000	-112,000	-112,000	No change
KIUC Power Purchases (kWh)	No change	-6,500,000	-9,021,000	-9,021,000	-9,441,000	No change
<i>Island-wide Perspective</i>						
Propane Consumption (Gal)	No change	No change	-5,230	No change	No change	No change
Diesel Oil Consumption (Gal)	-14,210	+27,000	-826,000	-841,000	-784,000	-761,600
Renewable Energy Production (kWh)	No change	No change	+12,210,100	+12,691,900	+12,057,300	+12,057,300

TABLE NO. 5-2
PRESENT WORTH OF THE SIX ALTERNATIVES
LOW STANDBY POWER COST SCENARIO

Alternative No. 1-A: Existing PMRF Power Plant with Heat Recovery and with Intermittent Operation	-\$209,000
Alternative No. 1-B: Existing PMRF Power Plant with Heat Recovery and with Continuous Operation	+\$4,077,000
Alternative No. 2-A: New LFGTE Plant at Existing PMRF Power Plant With Microturbine CHP Facility	+\$16,952,000
Alternative No. 2-B: New LFGTE Plant at Existing PMRF Power Plant Without Microturbine CHP Facility	+\$19,559,000
Alternative No. 3: New LFGTE Plant Near Landfill on PMRF	+\$22,168,000
Alternative No. 4: New LFGTE Plant at Landfill	+\$10,852,000

TABLE NO. 5-3
PRESENT WORTH OF THE SIX ALTERNATIVES
MEDIUM STANDBY POWER COST SCENARIO

Alternative No. 1-A: Existing PMRF Power Plant with Heat Recovery and with Intermittent Operation	-\$285,900
Alternative No. 1-B: Existing PMRF Power Plant with Heat Recovery and with Continuous Operation	+\$3,056,000
Alternative No. 2-A: New LFGTE Plant at Existing PMRF Power Plant With Microturbine CHP Facility	+\$15,534,400
Alternative No. 2-B: New LFGTE Plant at Existing PMRF Power Plant Without Microturbine CHP Facility	+\$18,141,000
Alternative No. 3: New LFGTE Plant Near Landfill on PMRF	+\$21,685,900
Alternative No. 4: New LFGTE Plant at Landfill	+\$10,852,000

TABLE NO. 5-4
PRESENT WORTH OF THE SIX ALTERNATIVES
HIGH STANDBY POWER COST SCENARIO

Alternative No. 1-A: Existing PMRF Power Plant with Heat Recovery and with Intermittent Operation	-\$209,000
Alternative No. 1-B: Existing PMRF Power Plant with Heat Recovery and with Continuous Operation	-\$1,725,000
Alternative No. 2-A: New LFGTE Plant at Existing PMRF Power Plant With Microturbine CHP Facility	+\$8,887,000
Alternative No. 2-B: New LFGTE Plant at Existing PMRF Power Plant Without Microturbine CHP Facility	+\$11,494,000
Alternative No. 3: New LFGTE Plant Near Landfill on PMRF	+\$13,735,000
Alternative No. 4: New LFGTE Plant at Landfill	+\$10,852,000

SECTION 6

CONCLUSIONS

The CHP alternative with the highest present worth is Alternative No. 2-B. It also offers the greatest island-wide reduction in diesel oil consumption.

Alternative No. 3 has a higher present worth than Alternative No. 2-B, but it does not employ CHP.

Alternative No. 2-B will be carried forward as the selected alternative.